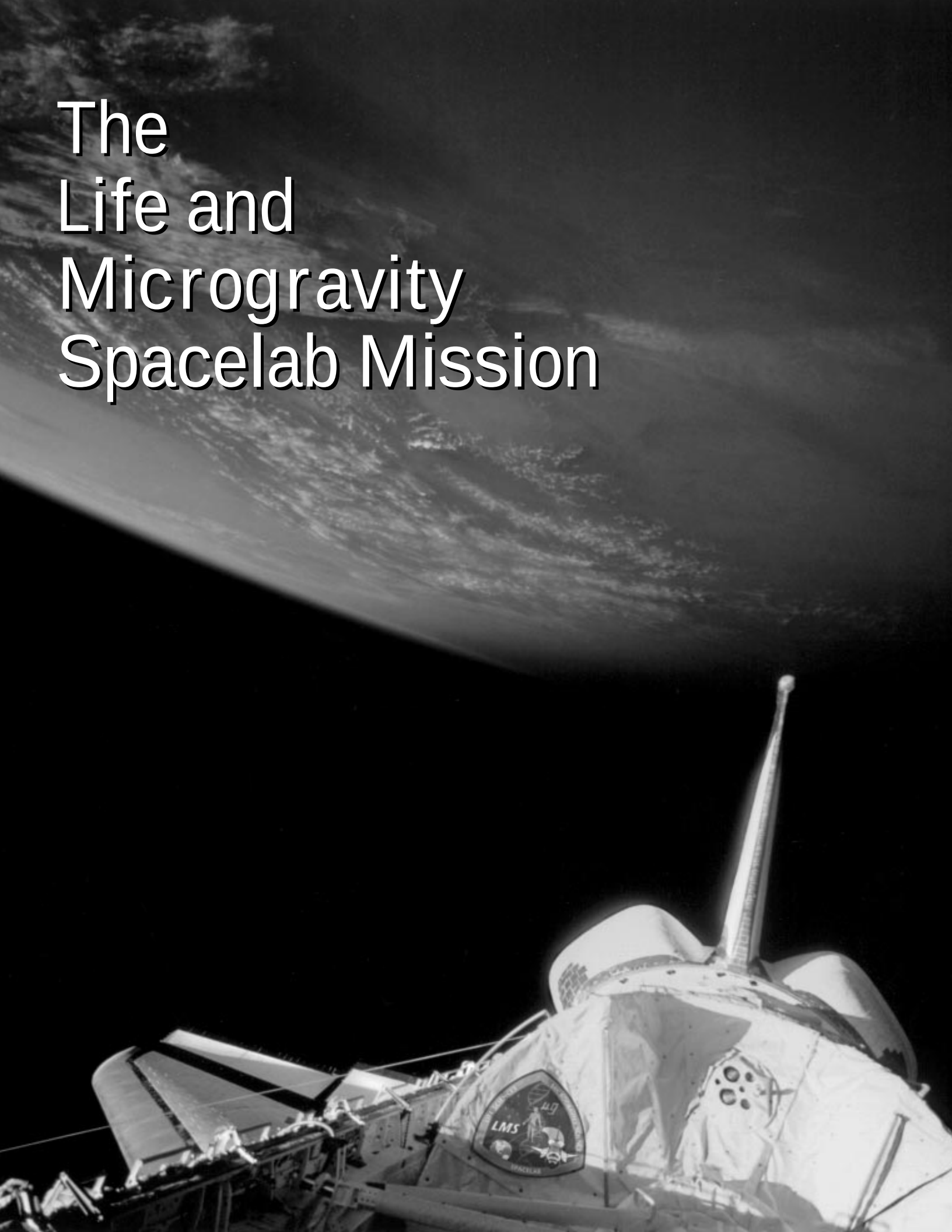
The Life and Microgravity Spacelab Mission



Mission Objective:

To conduct life and materials science investigations that require the unique low-gravity environment created inside an orbiting space laboratory free-falling around Earth.

Science Applications:

Materials science and life sciences are two of the most exciting areas of microgravity research because discoveries in these fields could enhance significantly the quality of life on Earth. If the structure of certain proteins can be determined by examining high-quality protein crystals grown in microgravity, advances can be made to improve the treatment of many human diseases. Space investigations in physiological processes may lead to remedies for loss of bone or muscle mass suffered by astronauts and people on Earth with osteoporosis. Electronic materials research in space may help us refine processes and make better products, such as computers, lasers, and other high-tech devices. Basic science investigations in biology and physics will increase our understanding of these fundamental processes.

Participating Agencies:

The LMS mission involves scientists from 10 countries, representing 5 international space agencies. The team has developed 41 experiments to study the effects of gravity on the human body, on the development of plants and animals, on the processing of protein crystals and metallic alloys, and on fluid behavior.

The National Aeronautics and Space Administration (NASA) is the United States agency dedicated to research and development of space science and technology. NASA manages the LMS mission, integrates the experiment facilities into a Spacelab payload, and provides transportation for the experiments on the Space Shuttle/Spacelab. The agency is headquartered in Washington, D.C.

esa
european space agency
agence spatiale européenne

The European Space Agency (ESA) sponsors space research and technology among 13 member states (Austria, Belgium, Denmark, France, Germany, Ireland, Italy, The Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom), one associate member (Finland), and one country (Canada) under a cooperative agreement. The agency is headquartered in Paris, France.

Canadian Space Agency | Agence spatiale canadienne

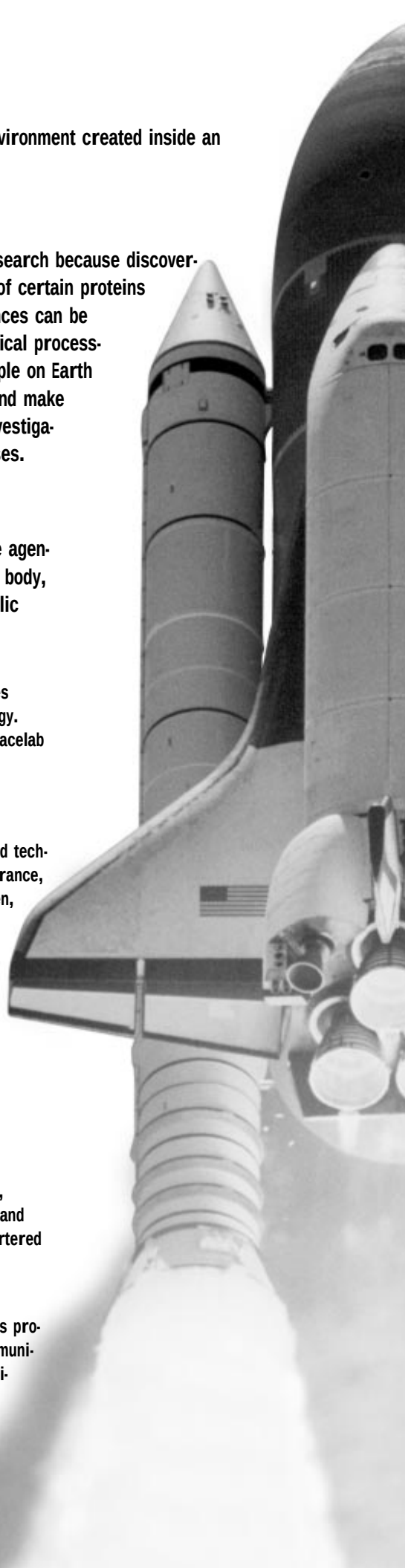
The Canadian Space Agency (CSA) acts as a focal point for Canada's space activities. The agency encourages and supports research, technology, and operations throughout Canada. CSA is headquartered in Montreal, Quebec, Canada.

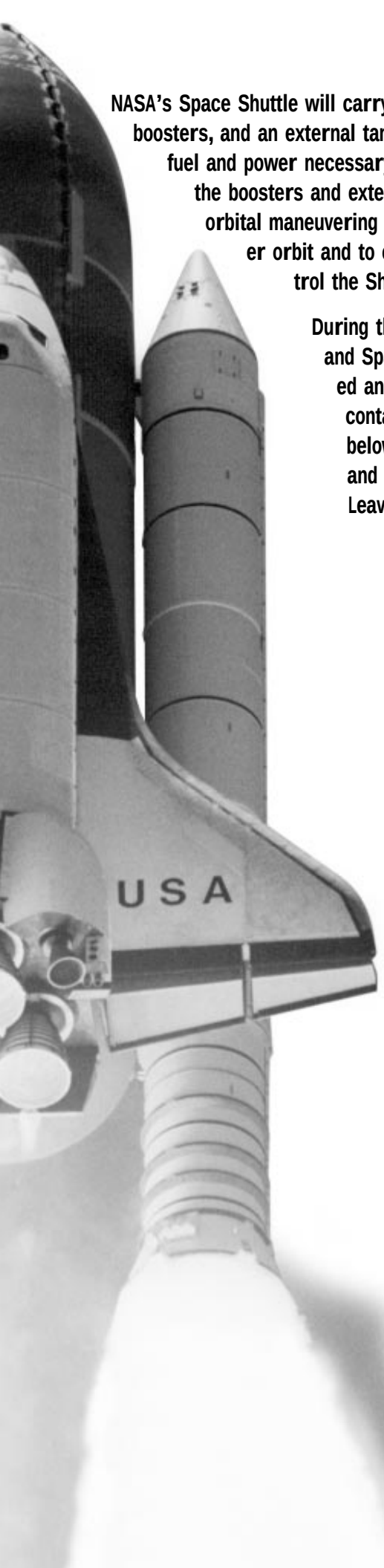
asi
agenzia spaziale italiana

The Italian Space Agency, Agenzia Spaziale Italiana (ASI) has the responsibility to promote, coordinate, and manage national, bilateral, and multilateral programs and to promote and support Italian scientific and industrial participation with the European Space Agency. ASI is headquartered in Rome, Italy.

cnes
AGENCE FRANÇAISE DE L'ESPACE

This agency is responsible for developing French space activities. For its program of basic research, it works in conjunction with the scientific community, using the laboratories of the National Scientific Research Center, universities, and many other organizations in France. The agency is headquartered in Paris, France.





NASA's Space Shuttle will carry the LMS mission into orbit. This system consists of an orbiter, two solid rocket boosters, and an external tank. The boosters, the external tank, and the orbiter's main engines provide the fuel and power necessary to lift the Space Shuttle into orbit. After their fuel is consumed during ascent, the boosters and external tank are jettisoned, and the orbiter's main engines are shut down. The orbital maneuvering system engines provide the remaining thrust to insert the Shuttle into the proper orbit and to change orbital velocity. The reaction control system thrusters are used to control the Shuttle's attitude and to make small maneuvers.

During the mission, the LMS crew will live and work in the orbiter flight deck, middeck, and Spacelab module. These areas are maintained at sea-level pressure, air is circulated and filtered, and temperature can be adjusted for crew comfort. The flight deck contains the controls and displays used to operate the orbiter. The middeck, located below the flight deck, consists of a galley, personal hygiene area, airlock, side hatch, and stowage lockers that hold the crew's gear and some experiment equipment. Leaving the middeck, the crew enters Spacelab through a 19-foot (6-meter) tunnel.

Life and Microgravity Spacelab Mission Facts

Launch and Prime Landing Site	Kennedy Space Center, Florida
Flight Number	STS-78
Shuttle Orbiter	Columbia
Altitude	150 nautical miles (278 kilometers)
Orbital Path	Circular
Inclination	39 degrees
Mission Attitude	Gravity Gradient
Mission Duration	16, plus 2 contingency days
Crew Size	7 crewmembers
Payload Experiments	Life Science and Microgravity Science
Payload Operations	Around the clock

LMS Management Team

NASA Headquarters is responsible for the LMS Program, which emphasizes life and microgravity sciences research. NASA's Marshall Space Flight Center is responsible for mission management.

Program Manager: David Jarrett, NASA Headquarters

Program Scientist: Dr. Victor Schneider, NASA Headquarters

Mission Manager: Mark Boudreaux, MSFC

Mission Scientist: Dr. James Patton Downey, MSFC

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LMS CREW

The Space Shuttle/Spacelab crew consists of flight crewmembers, mission specialists, and payload specialists. The flight crew – the Commander, Pilot, and Flight Engineer – are responsible for the operation and maintenance of the orbiter systems and flight tests on ascent, orbit, and re-entry. Mission Specialists are career NASA astronauts with education, background, and training that make them specifically qualified for the mission. The Payload Specialists are scientists chosen for flight, based on unique expertise, training, skills, and experience.

The LMS mission emphasis on multi-national cooperation is evidenced in the make-up of its crew. The flight crew and Mission Specialists from NASA's astronaut corps will be joined by four crewmembers from other nations: two Payload Specialists from Canada and France and two Alternate Payload Specialists from Spain and Italy.

Terence T. "Tom" Henricks (Col., USAF) Colonel Henricks will be the Commander for the LMS mission. He received a Bachelor of Science degree in Civil Engineering from the United States Air Force Academy and a Masters Degree in Public Administration from Golden Gate University. Col. Henricks served as an Air Force F-4 fighter pilot in Europe and Iceland and was an F-16C test pilot at Edwards Air Force Base, California, when selected by NASA. As an astronaut, he has performed duties in the Space Shuttle Program Office and the Astronaut Office. He was the pilot on STS-44 and STS-55, the German D-2 Spacelab mission. He recently commanded STS-70 and has logged more than 620 hours in space.

Kevin R. Kregel Mr. Kregel, a graduate of the U.S. Air Force Academy with a Bachelor's Degree in Astronautical Engineering, will be the LMS pilot. He obtained a Master's Degree in Public Administration from Troy State University and earned his pilot's wings at Williams Air Force Base, Arizona. As a pilot, he has logged more than 4,500 hours in 30 different aircraft. Mr. Kregel resigned from active duty in 1990 to serve as an aerospace engineer and instructor pilot with NASA. Since his selection as an astronaut, he has been assigned to the Mission Support Branch of the Astronaut Office and served on the Astronaut Support Personnel team at the Kennedy Space Center in Florida, supporting Space Shuttle launches and landings. He was the pilot on STS-70 and has logged more than 214 hours in space. LMS will be his second mission.

Susan J. Helms (Lt.Col., USAF) Lt. Col. Helms will be the LMS Payload Commander and Flight Engineer. She received a Bachelor of Science degree in Aeronautical Engineering from the U.S. Air Force Academy and a Master of Science in Aeronautics/Astronautics from Stanford University. Lt. Col. Helms was a flight test engineer in the Air Force, flying in 30 types of U.S. and Canadian military aircraft. Since becoming an astronaut in 1991, she has worked in payload development, robotics, and habitable module development and was responsible for air-to-ground communications with Space Shuttle crews while serving as Capsule Communicator (CAPCOM) on five missions. Lt. Col. Helms flew as Mission Specialist on STS-54 and STS-64, logging more than 406 hours of spaceflight.

Richard M. Linnehan (D.V.M.) Dr. Linnehan received a Bachelor of Science degree in Animal Science with a minor in Microbiology from the University of New Hampshire and the degree of Doctor of Veterinary Medicine from the Ohio State University College of Veterinary Medicine. After 2 years of private practice and subsequent completion of a 2-year internship in exotic animal medicine and pathology at the Baltimore Zoo and Johns Hopkins University, Dr. Linnehan entered military service as a captain in the U.S. Army Veterinary Corps. During his tour of duty, he served as chief veterinarian/officer in charge of the U.S. Navy's marine mammal programs in San Diego, California; Key West, Florida; and Kaneohe, Hawaii. Dr. Linnehan was selected as a Mission Specialist by NASA in 1992 and currently is assigned to the Astronaut Office Mission Development Branch, working on payload and mission development for future Space Shuttle missions. LMS will be his first spaceflight.

Charles E. Brady, Jr. (Commander, USN) CMDR. Brady, Mission Specialist, is a Navy flight surgeon who received his training at the Naval Aerospace Medical Institute. He studied pre-medicine at the University of North Carolina at Chapel Hill and received the degree of Doctor of Medicine from Duke University. CMDR. Brady served aboard the aircraft carrier USS Ranger and was the flight surgeon for the prestigious Blue Angels squadron. Since becoming an astronaut in 1992, his assignments have included astronaut representative to the Human Research Policy and Procedures Committee and deputy chief for Space Shuttle astronaut training. CMDR. Brady is an amateur radio operator and an Eagle scout. LMS will be his first flight.

Robert B. Thirsk (M.D.) Dr. Thirsk was one of the six individuals chosen in 1983 as the first group of astronauts for the Canadian Space Agency. He earned a Bachelor of Science degree in Mechanical Engineering from the University of Calgary, a Master of Science degree in mechanical engineering from the Massachusetts Institute of Technology, and the degree of Doctor of Medicine from McGill University. As a career astronaut with the Canadian Space Agency, Dr. Thirsk pursues advanced astronaut training, payload operations, collateral duties, clinical practice, and research. He was an investigator for three experiments that flew on previous Spacelab missions and was an Alternate Payload Specialist on the IML-1 mission. Dr. Thirsk will be a Payload Specialist on LMS, his first spaceflight.

Jean-Jacques Favier (Ph.D.) Dr. Favier, Payload Specialist, received an engineering degree from the National Polytechnical Institute of Grenoble and a doctorate degree in Engineering from the Mining School of Paris. Dr. Favier was the Principal Investigator for the MEPHISTO program on the United States Microgravity Payload missions in 1992 and 1994. He was an Alternate Payload Specialist on the IML-2 mission and has been the Principal Investigator for 10 other space experiments in coordination with ESA, NASA, and the Russian space agency. Dr. Favier currently works with the MSFC Payload Operations Laboratory, the Space Station Furnace Facility team, and the Microgravity Center at the University of Alabama in Huntsville. He will be making his first Space Shuttle flight.

Pedro Duque Mr. Duque, a native of Spain, joins the LMS mission as one of the two Alternate Payload Specialists. He received his Master's degree in Aeronautical Engineering from the Polytechnical University School of Aeronautical Engineering in Madrid. As part of his studies, Mr. Duque worked on a fellowship in the Flight Mechanics Laboratory on a flight simulator project. He also served as part of the Flight Control Team for the First European Remote-Sensing Satellite (ERS-1) and European Retrievable Carrier (EURECA) spacecraft. Mr. Duque became an ESA astronaut in 1992 and has since trained at Star City, Russia, in preparation for upcoming ESA/Russian collaborative space efforts. He specifically trained with the Russians as part of the EUROMIR 94 mission. LMS will be his first NASA Space Shuttle assignment.

Luca Urbani (M.D.) Dr. Urbani received the degree of Doctor of Medicine from the University of Rome and then completed residencies in Otorhinolaryngology and in Audiological Medicine at the Universities of Rome and Naples, respectively. He is a Lieutenant Colonel in the Italian Air Force Medical Corps, where he has been serving since 1987 as a research medical officer at D.A.S.R.S. - Department of Aerospace Medicine. He received advanced training at the United States Air Force School of Aerospace Medicine and has taught aerospace medicine courses at his medical school alma mater, as well as in the Italian Air Force. Dr. Urbani was chosen as an astronaut candidate by the Italian Space Agency in 1991 and has worked with ESA on various science initiatives. Dr. Urbani, an accomplished glider pilot, will be an Alternate Payload Specialist for the LMS mission, his first NASA mission assignment.

LIFE AND

RACK 2

Spacelab Control Center: **Houses the computer center for managing data and for operating laboratory systems and certain experiments. Some of these activities are carried out by the crew, while others are performed automatically by computers.**

RACK 4

Standard Spacelab Subsystems: **Contains a fluid loop pump that supports experiment cooling, video recorders that support all payload data, and an experiment heat exchanger.**

RACK 6

Stowage **for BDPU.**

RACK 8

Bubble, Drop, and Particle Unit (BDPU): **Contains special optical diagnostics, cameras, and sensors for studying fluid behavior in microgravity.**

RACK 10

Standard Interface Rack (SIR): **Provides standardized experiment interfaces for use in Spacelab and simplifies the removal and installation of experiments on orbit. The SIR consists of a rack liner, which provides for mechanical installation of the experiment modules and includes the power and data harness system for internal rack power distribution and data communications. For LMS, the SIR system includes two eight-panel stowage drawers and one four-panel stowage drawer.**

Astronaut Lung Function Experiment **hardware, such as the Bag-in-Box, Electronics Control Assembly, and Oxygen and Mixed Gas Cylinder Assemblies, which support the pulmonary and exercise experiments.**

Microcomputers **designed to use with the pulmonary and exercise experiments and to provide downlink signals compatible with the Spacelab data system.**

Life Sciences Laboratory Euipment (LSLE) Gas Analyzer System for Metabolic Analysis Physiology (GASMAP): **Used to monitor and analyze a crewmember's inhaled and exhaled breath stream to determine gas concentrations. The GASMAP contains the necessary hardware to perform respiratory gas analysis, gas volume measurement, and data acquisition of other parameters related to metabolic assessment.**

Electronics Drawer Assembly: **Contains the electronics, microcomputer, dc power source, and safety circuit switches for the Torque Velocity Dynamometer (TVD).**

RACK 12

Rack-Mounted Centrifuge: **Provides centrifugal acceleration for separation or processing of samples in hematology, bacteriology, microbiology, immunology, and other Life Sciences disciplines.**

GASMAP Calibration Module: **Used with GASMAP hardware, which is located in Rack 10.**

Space Linear Acceleration Mass Measurement Device (SLAMMD): **Determines the body mass of individual crewmembers in a microgravity environment through analysis of the acceleration response to the application of a standardized pulling force.**

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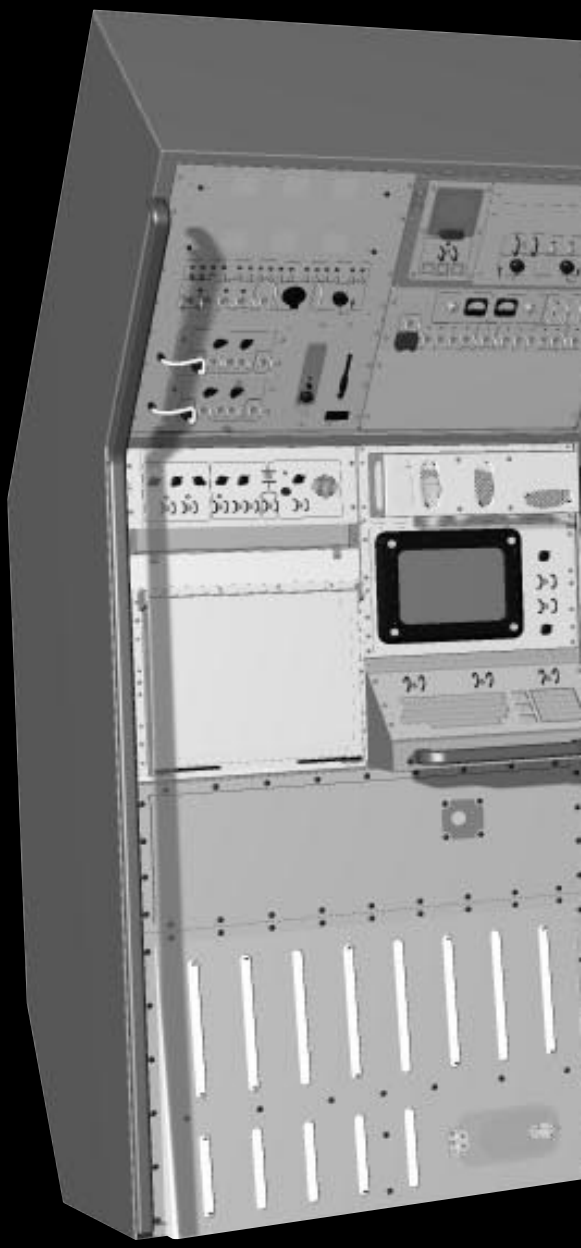
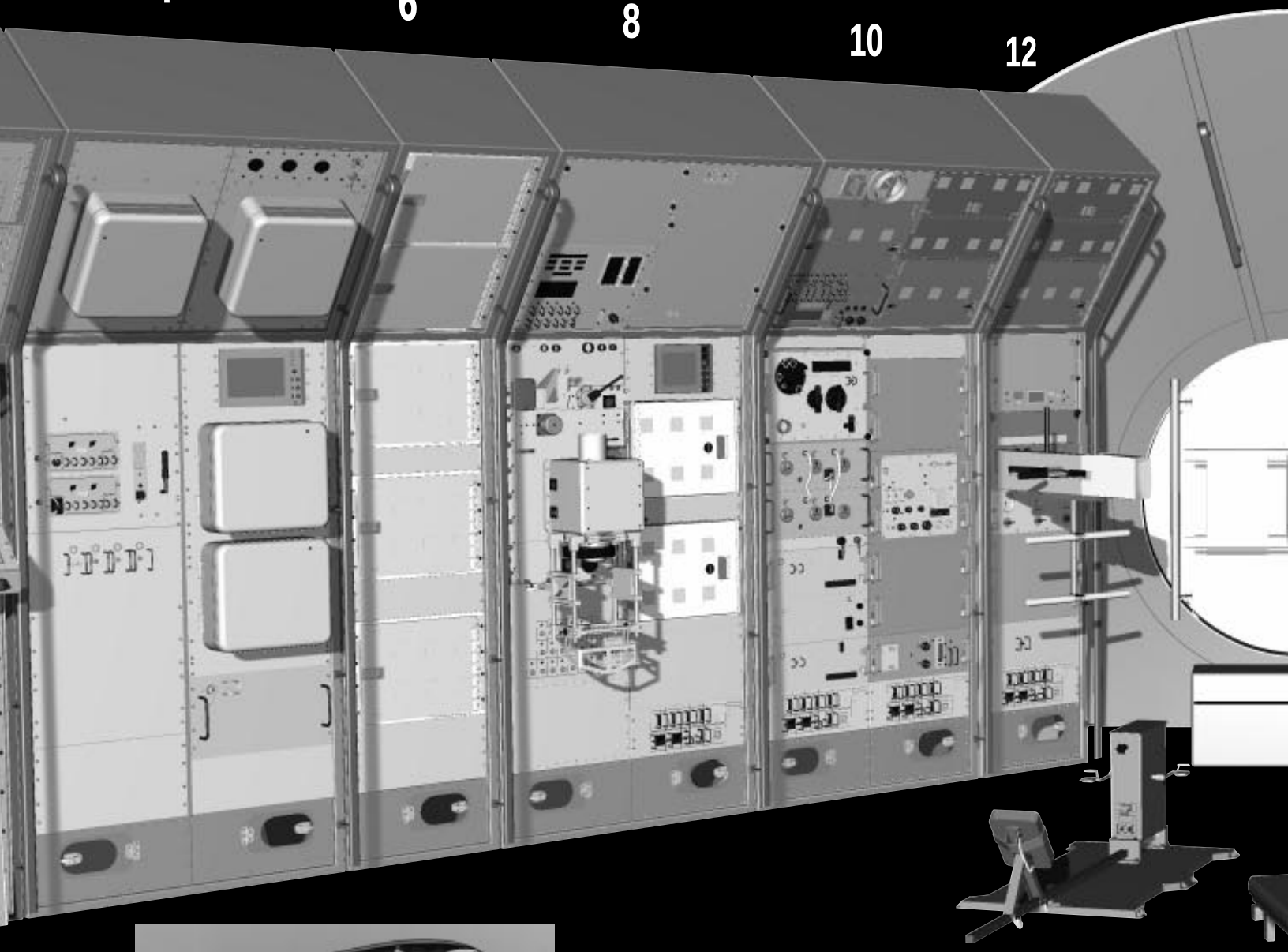
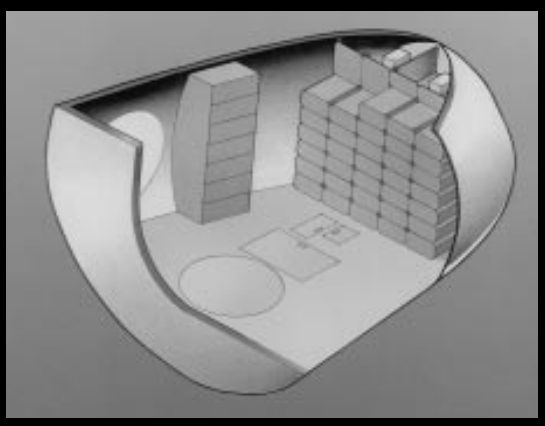


MICROGRAVIT

LMS Rack C

**The LMS Mission uses a pressurized Spacelab Module cont
ments, and utilities. Most experiment facilities are mounted
the middeck, and one experiment wi**





MIDDECK

Lockers in this part of the Shuttle carry additional supplies and hardware, including equipment for the following experiments:

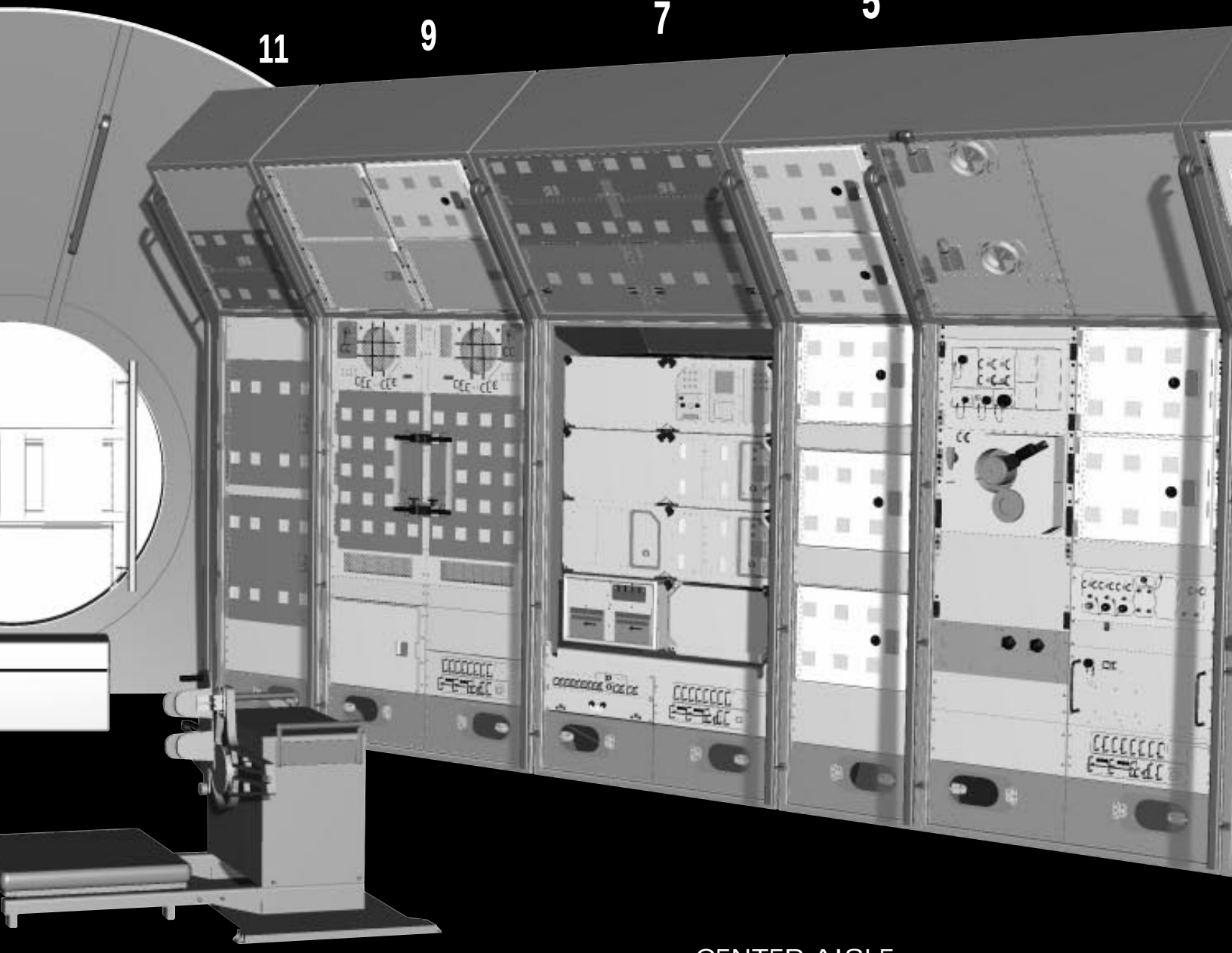
Plant Growth Facility (PGF): Contains 6 Plant Growth Chambers, which support whole-plant growth for up to 30 days under normal growing conditions.

Animal Enclosure Module (AEM): Provides rodent inhabitants with living space, food, water, ventilation, and lighting.

TY SPACELAB

Configuration

**taining computers,work areas, instrument racks for experi-
in 12 racks in this laboratory module; others are located in
ll be performed in the aft flight deck.**



Human Sleep, Circadian Rhythms, and Performance in Space (SACS): **Measures sleep, circadian rhythms, and task performance of subjects in response to the microgravity environment.**

Torso Rotation Experiment (TRE): **Monitors rotational movements of the eye, head, and upper torso in crewmembers as they perform routine activities.**

CENTER AISLE

Torque Velocity Dynamometer (TVD): **Measures the mechanical power of the leg and arm muscles; serves as the platform for the in-flight musculoskeletal activities.**

Bicycle Ergometer: **Provides various exercise levels/capabilities to the crew for cardiovascular conditioning and for musculoskeletal and pulmonary tests.**

OVERHEAD

Stowage **for BDPU and the JSC Life Sciences.**

MISSION

1

RACK 1

Workbench: Equipped with stowage containers, tools, and small equipment for carrying out general activities, such as recording medical data in logs or preparing for an experiment.

RACK 3

Advanced Gradient Heating Facility (AGHF): A Bridgman furnace supporting the production of advanced semiconductor materials and alloys using the directional solidification process. It provides an extremely stable temperature environment, high-temperature gradients, slow movement of the gradient across a sample, efficient cooling through the use of a liquid metal ring, and Peltier pulse marking capability.

Microgravity Measurement Assembly (MMA): A microgravity monitoring system capable of providing real-time display of accelerations that are detected by three sensors heads.

RACK 5

Stowage for experiment equipment and samples.

RACK 7

Spacelab Middeck Experiments (SMIDEX) — Equipment for the Canal and Otolith Integration Studies (COIS): Investigates changes in the coordination of head and eye movements associated with adaptation to microgravity and examines how vestibular and visual information is processed in the absence of a gravitational reference.

Space Acceleration Measurement System (SAMS): An electronics package with remote accelerometers placed in three locations in Spacelab to measure accelerations, such as those caused by Shuttle maneuvers or on-board activity. Information collected by this system will help scientists understand how accelerations occur inside Spacelab and how they affect microgravity experiments.

Advanced Protein Crystallization Facility (APCF): Allows three methods of protein crystal growth: liquid-liquid diffusion, dialysis, and the hanging drop method.

Space Tissue Loss Module – Configuration B (STL-B): Supports studies of mammalian cells, tissue cultures, and embryos and is easily modified to accommodate studies of amphibians, plants, organic crystals, and other biotechnology research.

RACK 9

Johnson Space Center Life Sciences Laboratory Equipment (LSLE) Freezer: Freezes perishable biological specimens, such as blood samples, to preserve them for postflight analysis. Two units will be flown, and each has a temperature range from -22 °C to +10 °C.

RACK 11

Stowage for BDPU and the Life Science projects.